Shared Information and Virtual Surfaces

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Long Term Goals

- Investigate performance of self-synchronizing teams

- Understand how teams collaborate on a shared surface in situations characterized by high stakes, uncertainty and time pressure

STRUCTURAL MODEL OF TEAM COLLABORATION
(MACRO-COGNITIVE PROCESS FOCUS)

Problem Area Characteristics

Collaborative Situation Parameters:

- time pressure
- information/knowledge uncertainty
- dynamic information
- large amount of knowledge (cognitive overload)
- human-agent interface complexity

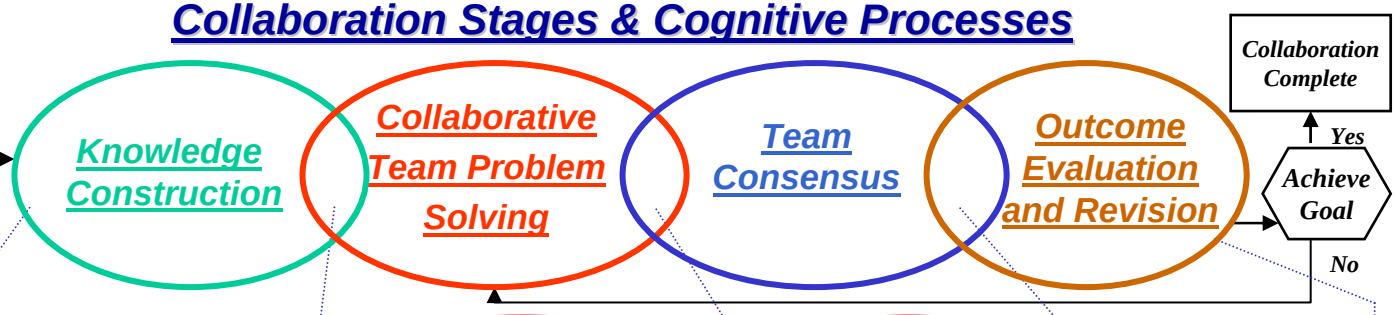
Team Types

- asynchronous
- distributed
- culturally diverse
- heterogeneous knowledge
- unique roles
- command structure (hierarchical vs. flat)
- rotating team members

Operational Tasks

- team decision making, COA selection
- develop shared understanding
- intelligence analysis (team data processing)

Collaboration Stages & Cognitive Processes



Meta-Cognitive:

- individual conversion of data to knowledge
- team integration of individual knowledge for common understanding
- team agreement on a common solution
- solution adjustment to fit goals and exit criteria

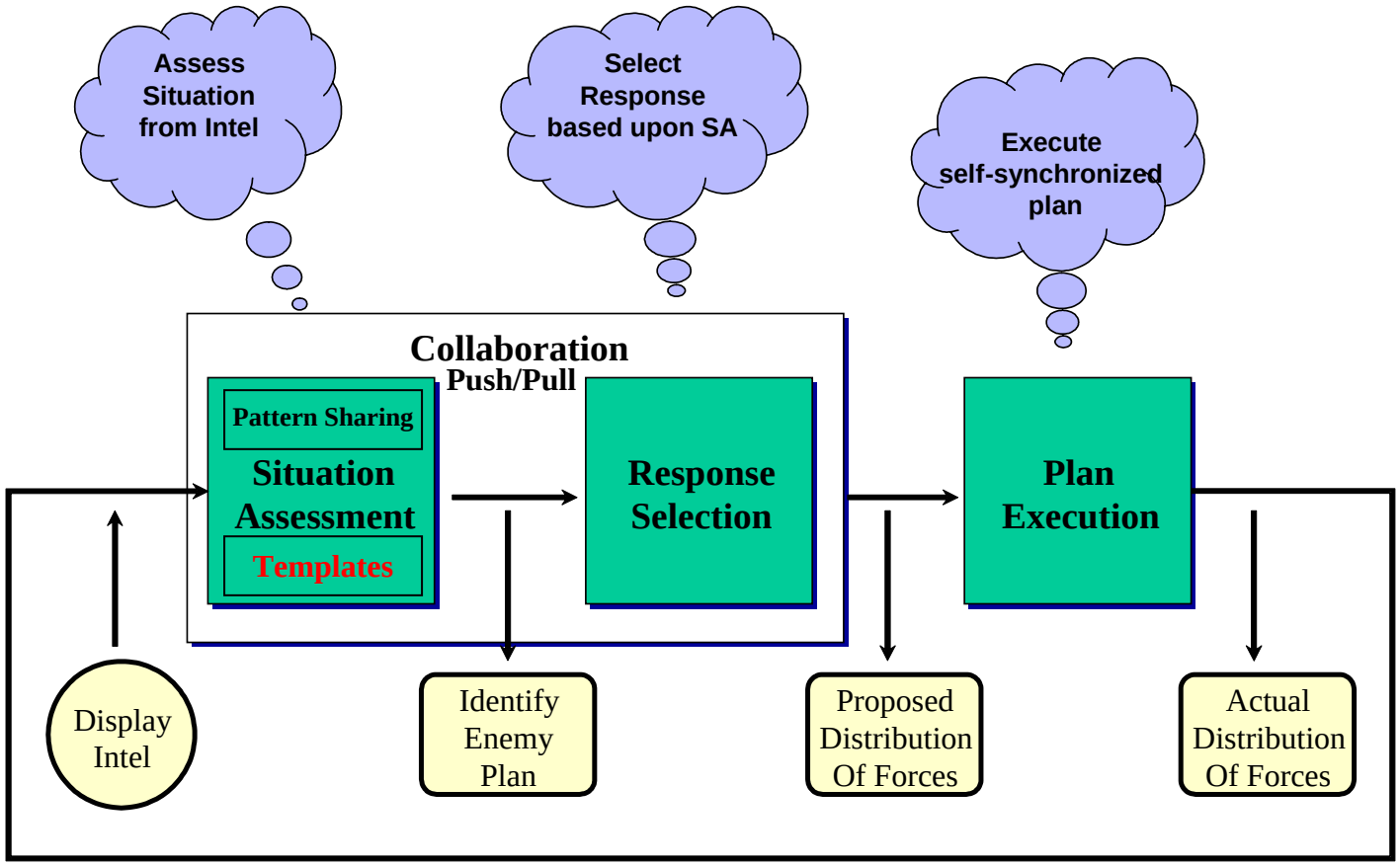
Macro-Cognitive:

- individual mental model construction
- knowledge interoperability development
- individual task, team and domain knowledge development
- individual knowledge object development
- individual visualization and representation of meaning
- knowledge interoperability development
- iterative information collection and analysis
- team shared understanding development
- develop, rationalize, & visualize solution alternatives
- convergence of individual mental models to team mental model
- individual task, team and domain knowledge development
- developing new knowledge
- team agreement on situation
- team negotiation of solution alternatives
- team pattern recognition
- team shared understanding development
- convergence of individual mental models
- critical thinking
- sharing hidden knowledge
- individual task knowledge development (continued)
- team task knowledge development (continued)
- compare problem solution against goals
- team shared understanding development
- convergence of individual mental models of solution
- analyze, revise output

Mechanisms for achieving Meta, Macro, and Micro-Cognitive Processes (applies to all stages)

- **Verbal communications:** presenting and discussing individual information, discussing team generated information. questioning, agreeing / disagreeing, negotiating perspectives, discussing possible solutions, providing rationale.
- **Non-Verbal communications:** facial expressions, voice clues (vocal paralanguage), hand gestures, body movements (kinesics), touch (haptics), personal space, drawing, text messages, augmented video, affordances (cognition in objects).

Research Model



Team Recognition Primed Decision Making

Project Objective

- Validate Model:

  Team Recognition Primed Decision-Making

- Empirical investigation for validity of:
  - **Pattern Sharing of Cognitive Chunks**
  - **Negotiated Interrupts (Push/Pull)**

Current Research Plan

- Extend Model
  - **Items Sharing vs. Chunks Sharing**
  - **Time Pressure**
  - **COA selection (bumping)**
  - **Incorporate Template Theory**

Fernand Gobet and Herb Simon

- Experienced people create complex structures called “templates”
- Templates have a *core* and *slots* and *linkages* to other templates which facilitates **fast** access to long term memory
- Templates can store at least 10 items and are often labeled

Chess Template

a)

Template-core:

White ♙c4, ♙d5, ♙e4, ♙f2, ♙g2, ♔g1, ♘c3, ♗e2

Black ♟c7, ♟d6, ♟e5, ♟f7, ♟g6, ♟h7, ♚g8, ♝c8, ♞f6, ♝g7

Slot for pieces:

♙ : h2, h3

♟ : a7, a5

♞ : b8, d7, c5

♜ : f8, e8

♕ : c2, d1

♗ : c1, d2, e3

Slot for squares:

d2 : ♘, ♗, empty

e8 : ♜, ♞, empty

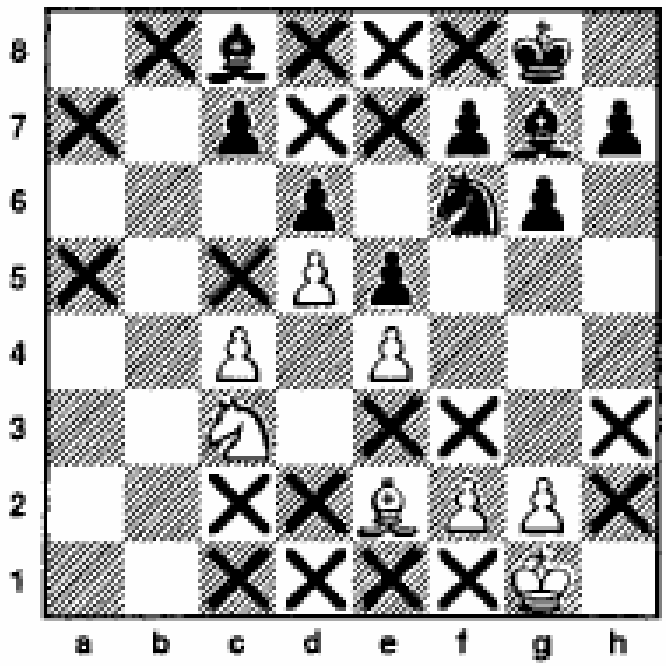
e1 : ♖, ♘, empty

Slot for opening: King's Indian Defense

Slot for plans: Break in the center with f7-f5

Slot for moves: 1... Nf6-e8
1... Nf6-h5

Links to other templates: chunk #231



FY '03 Research Plan

- Explore sharing of pattern chunks
  - **Labels**
  - **Templates (core and slots)**
- Rewards for **speed** and **accuracy**
- Explore implication of bumping on *slot* information

Hypotheses

- **Teams using a compensatory aid for pattern-recognition tasks will outperform teams who do not.**
- **Teams sharing *chunk/template labels* for pattern-recognition tasks will outperform teams who share individual items.**
- Teams using negotiated interrupts with each other for pattern-recognition tasks will outperform teams who do not.

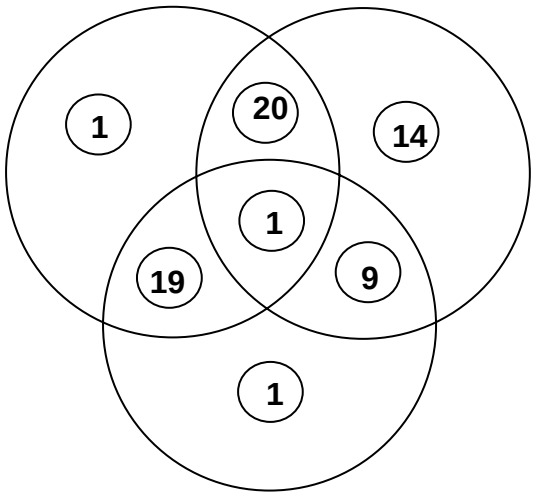
FY '03 Progress

- Data Collected and Analysis Performed:
  - Chunking (39 subjects)
  - Chunking Time Pressure (36 subjects)
  - No Sharing Time Pressure (36 subjects)
  - No Sharing/Bumping Time Pressure (45 subjects)
  - Continuous performance task "pilot" (21 subjects)
- International Journal of Human Computer Studies
  - first article from last year's results accepted.
- ICIS Cognitive Workshop, DSS2004 Conference
- OBHDP (submitted)
- ACM Transactions on CHI (close draft)

Decision Game

- Cooperative 3-Player Game
- Each player has 7 Tokens (numbered 1-7)
- Opponent has asymmetric force
  - Patterns: Definitive, Equivocal, Uncertain
- Team places tokens so total >= opponent
- Incentive
  - For total points
  - For time of play
- Play is interactive

Patterns



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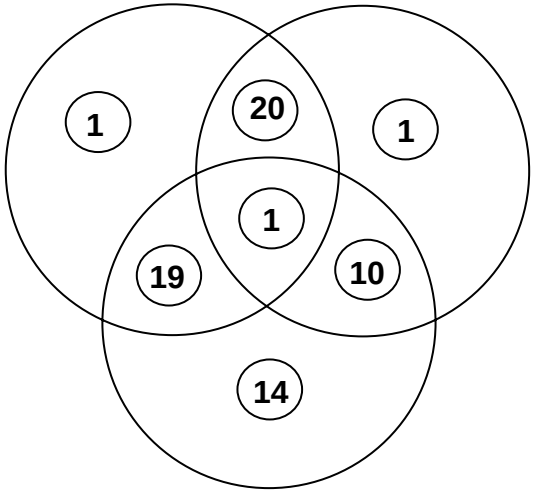

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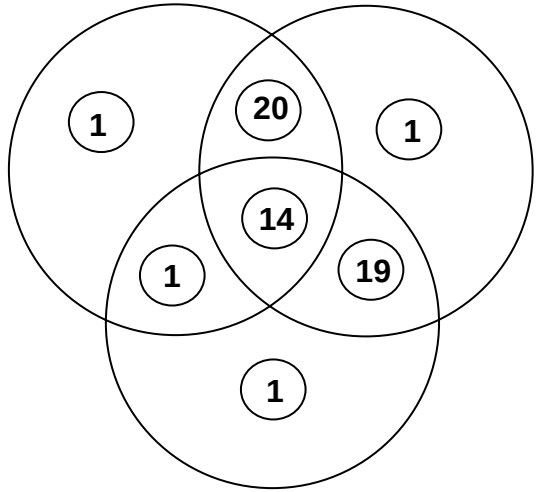

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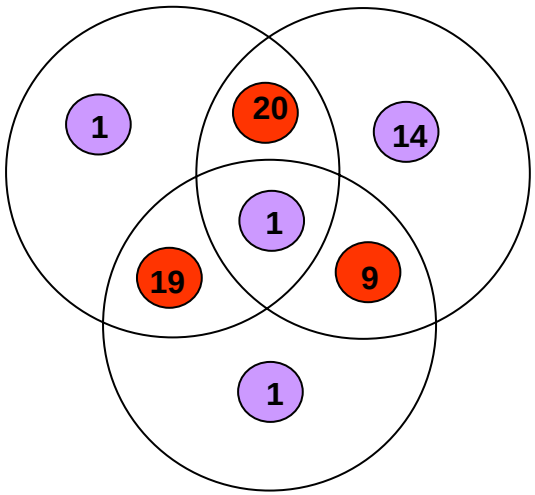
Chunk Labels

Our Patterns as Templates



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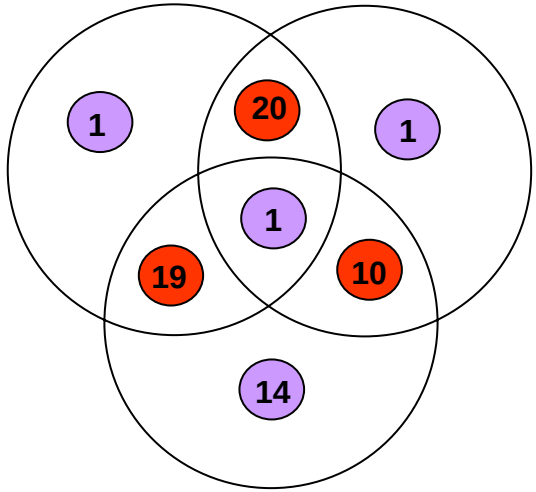

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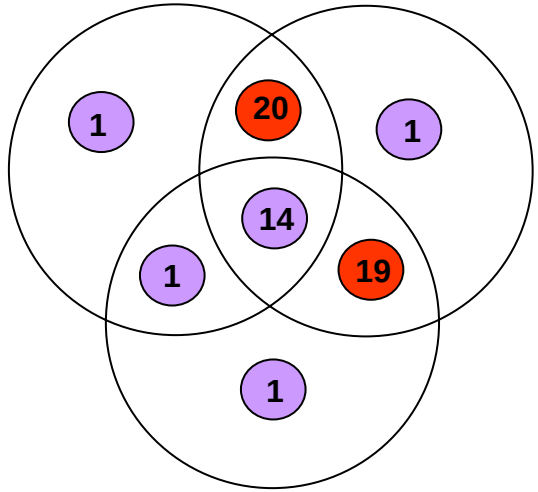

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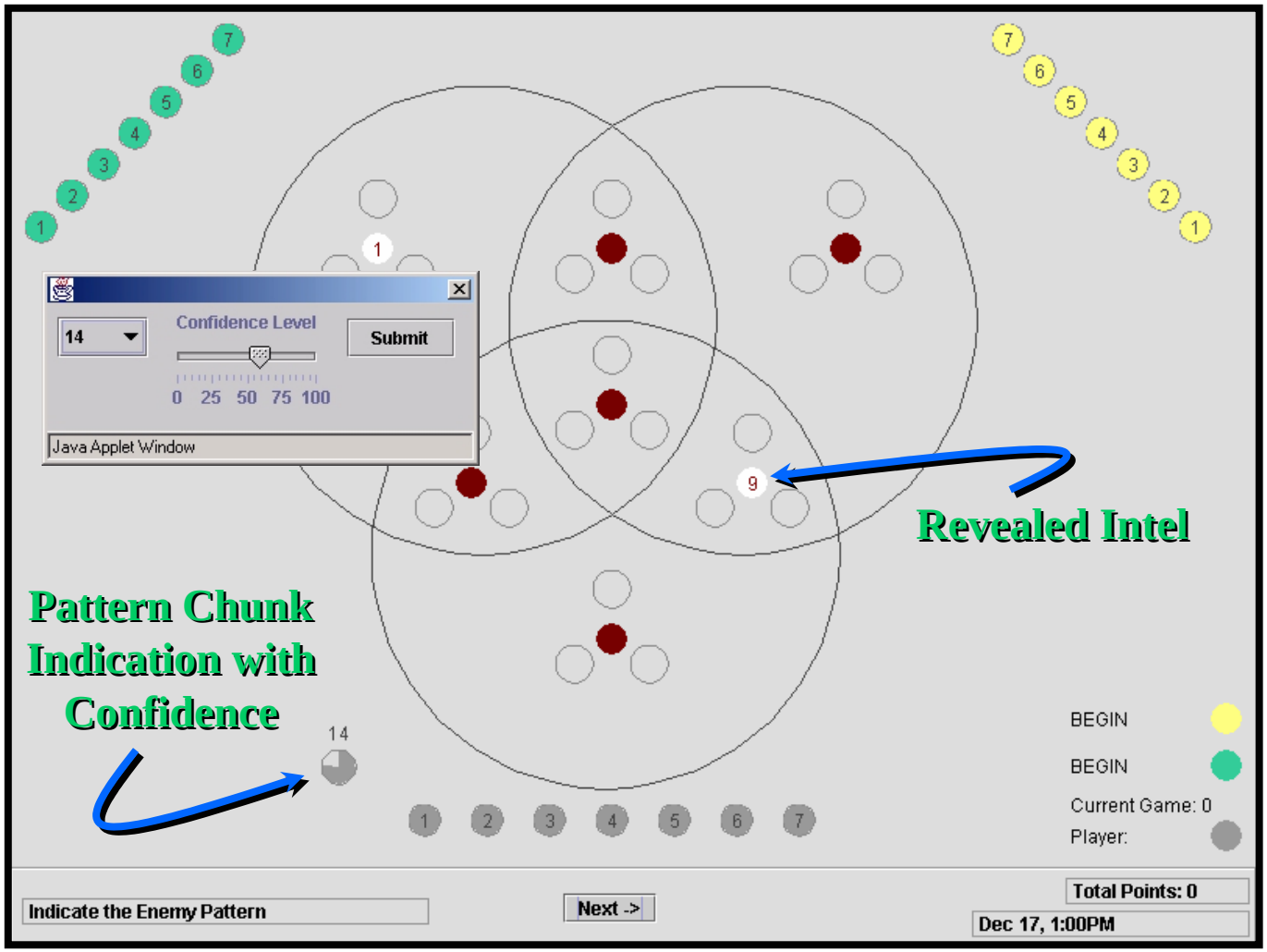
Core

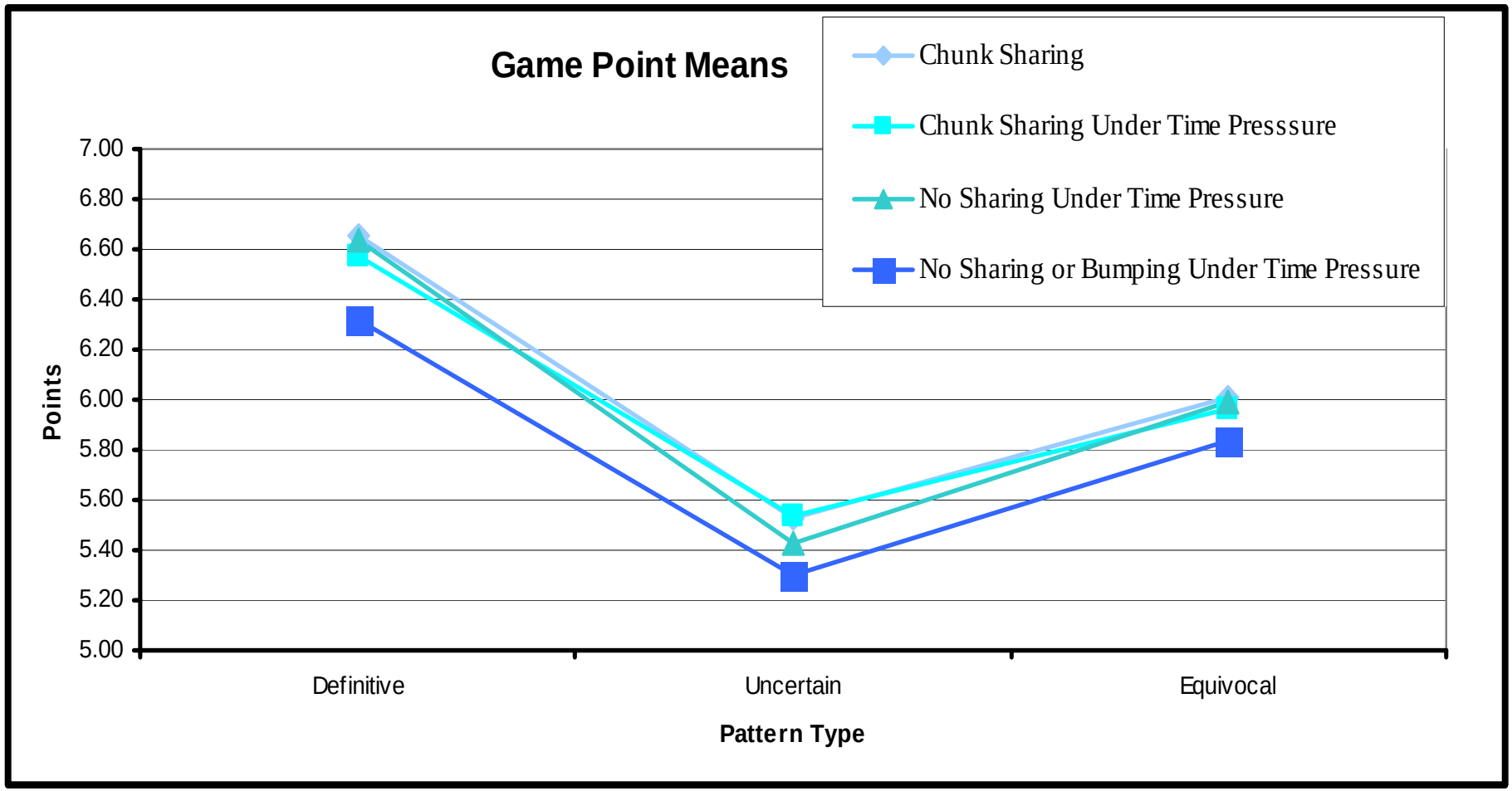
Slots

Need video!!!

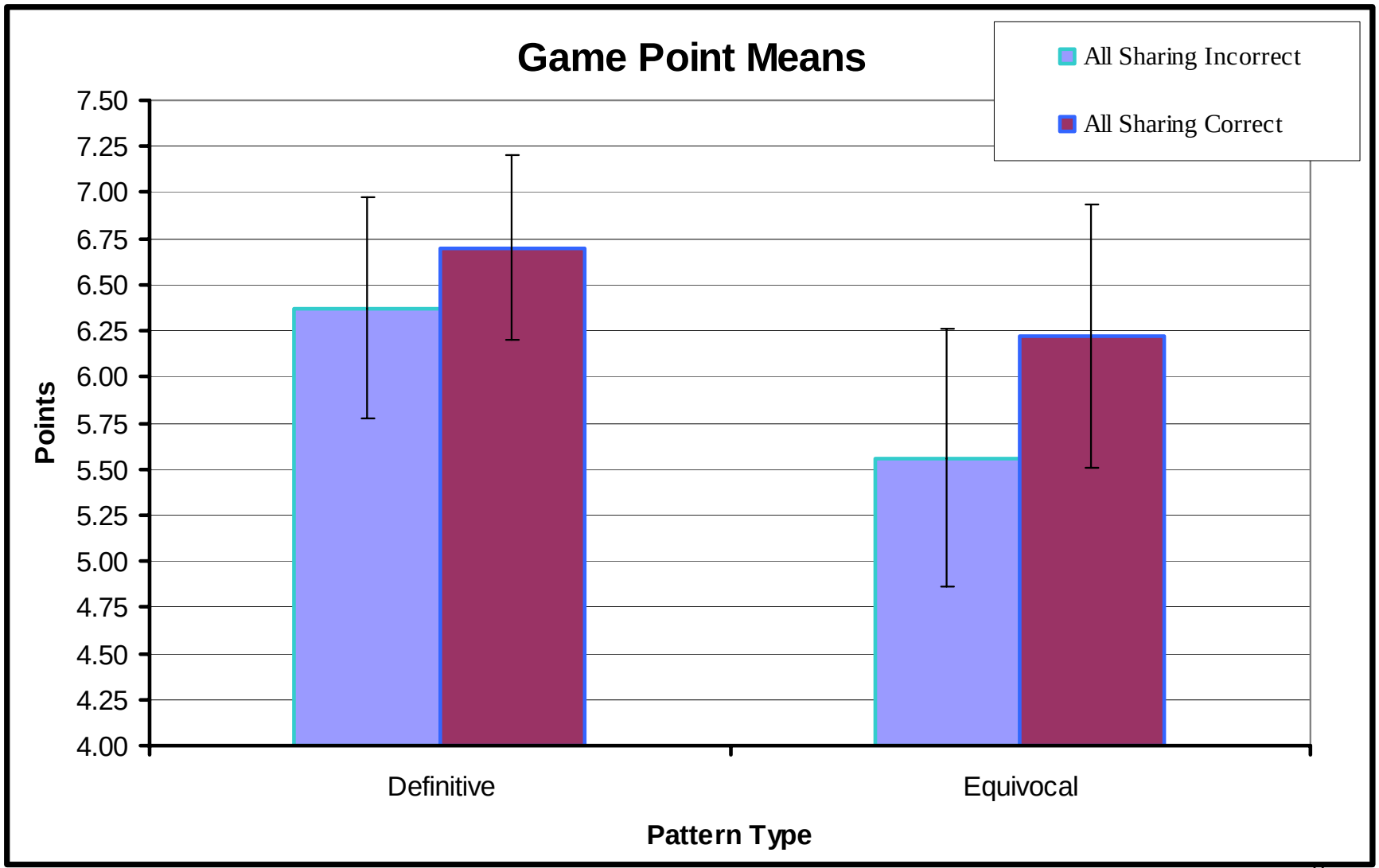
Pattern Chunks



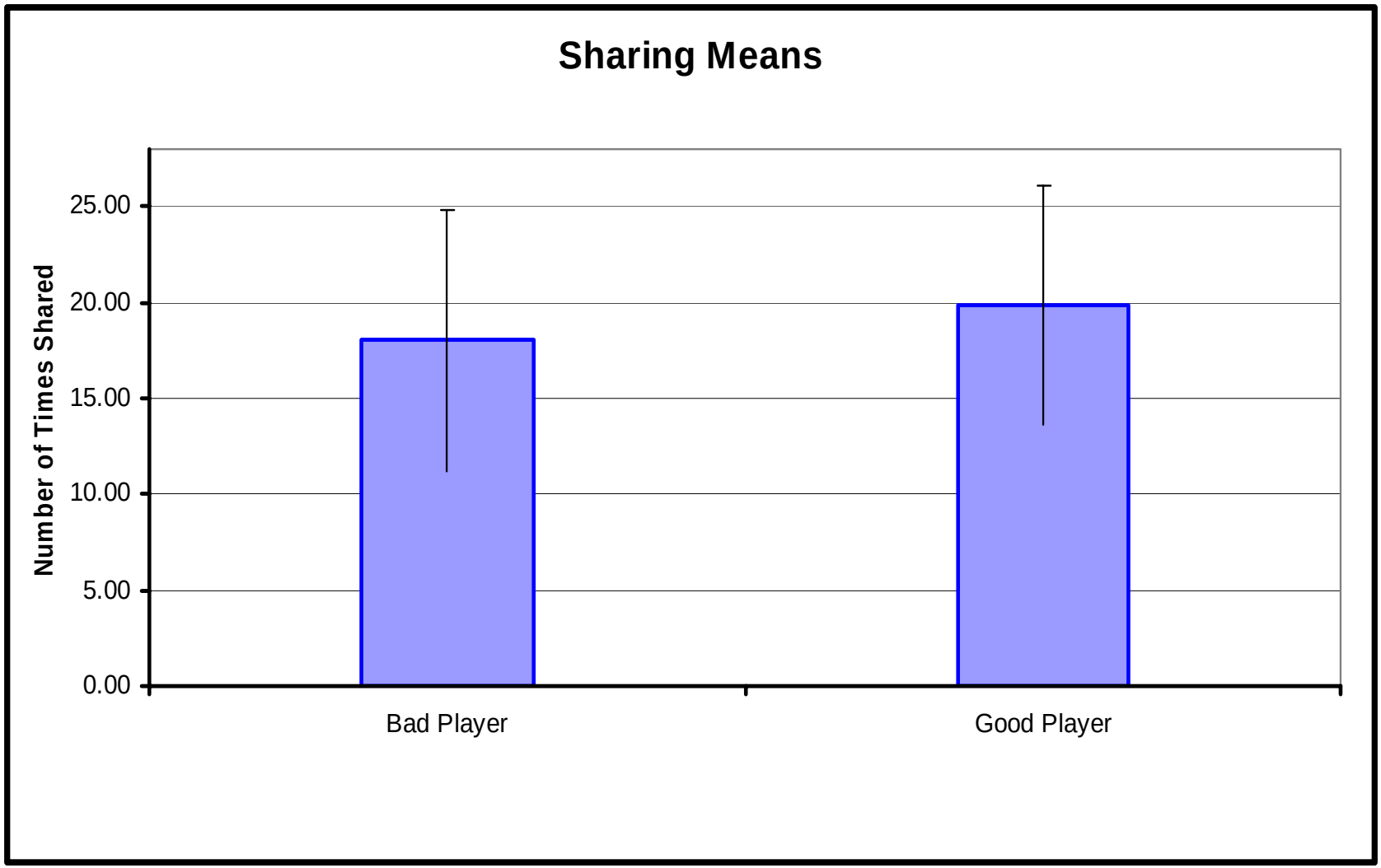
Chunking Treatments - Performance



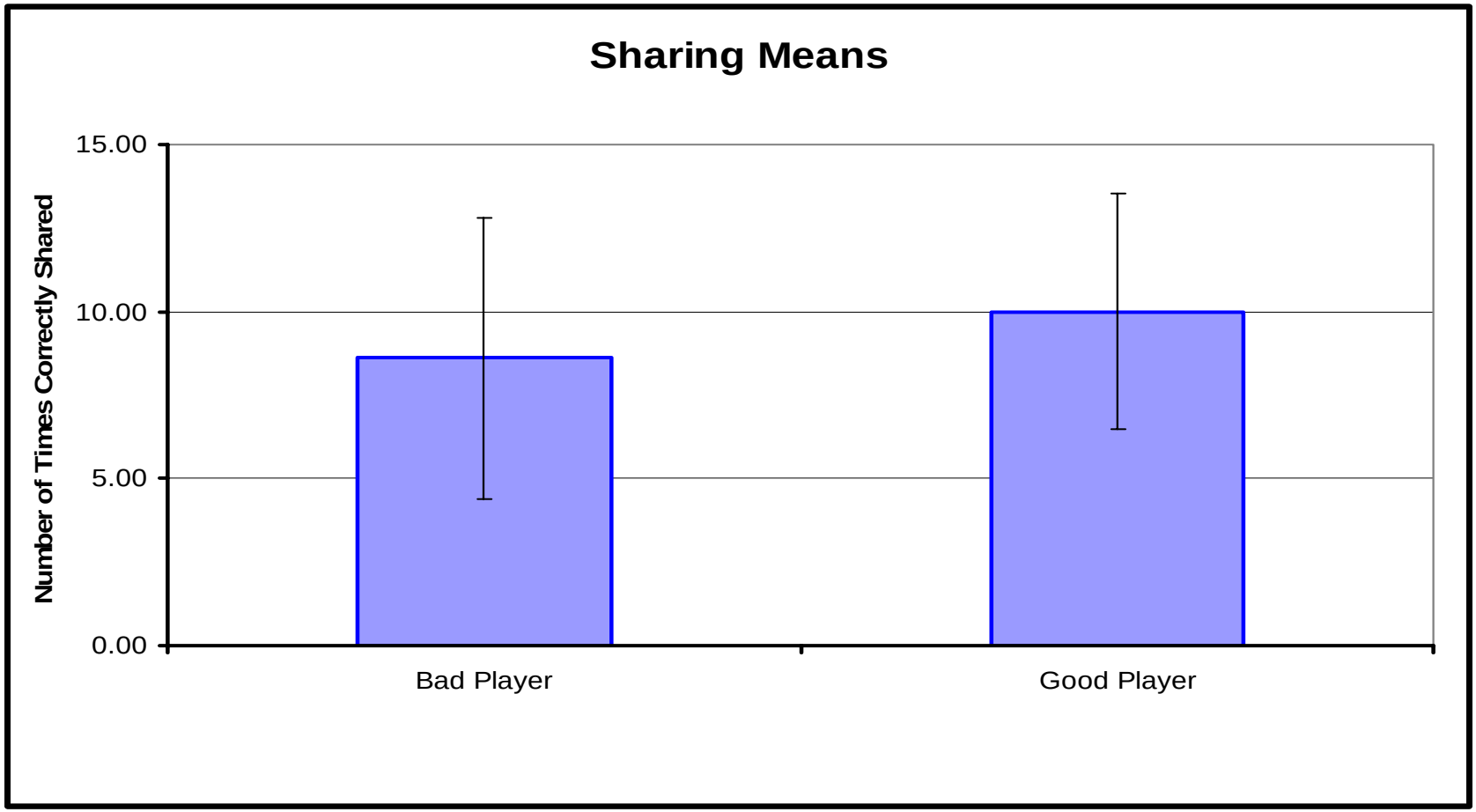
Sharing Correctness and Performance



Player Type and Sharing

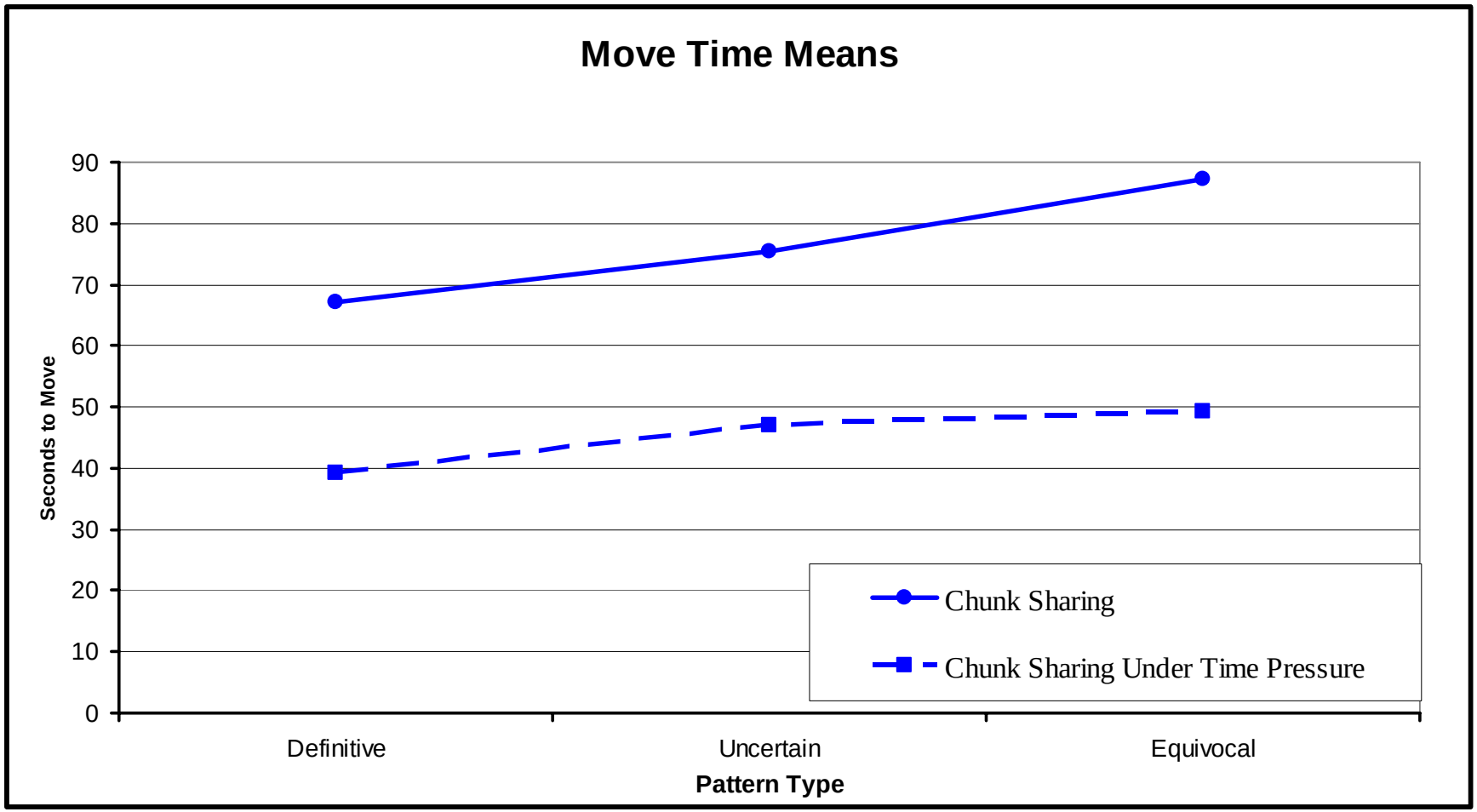


Player Type and Correct Sharing



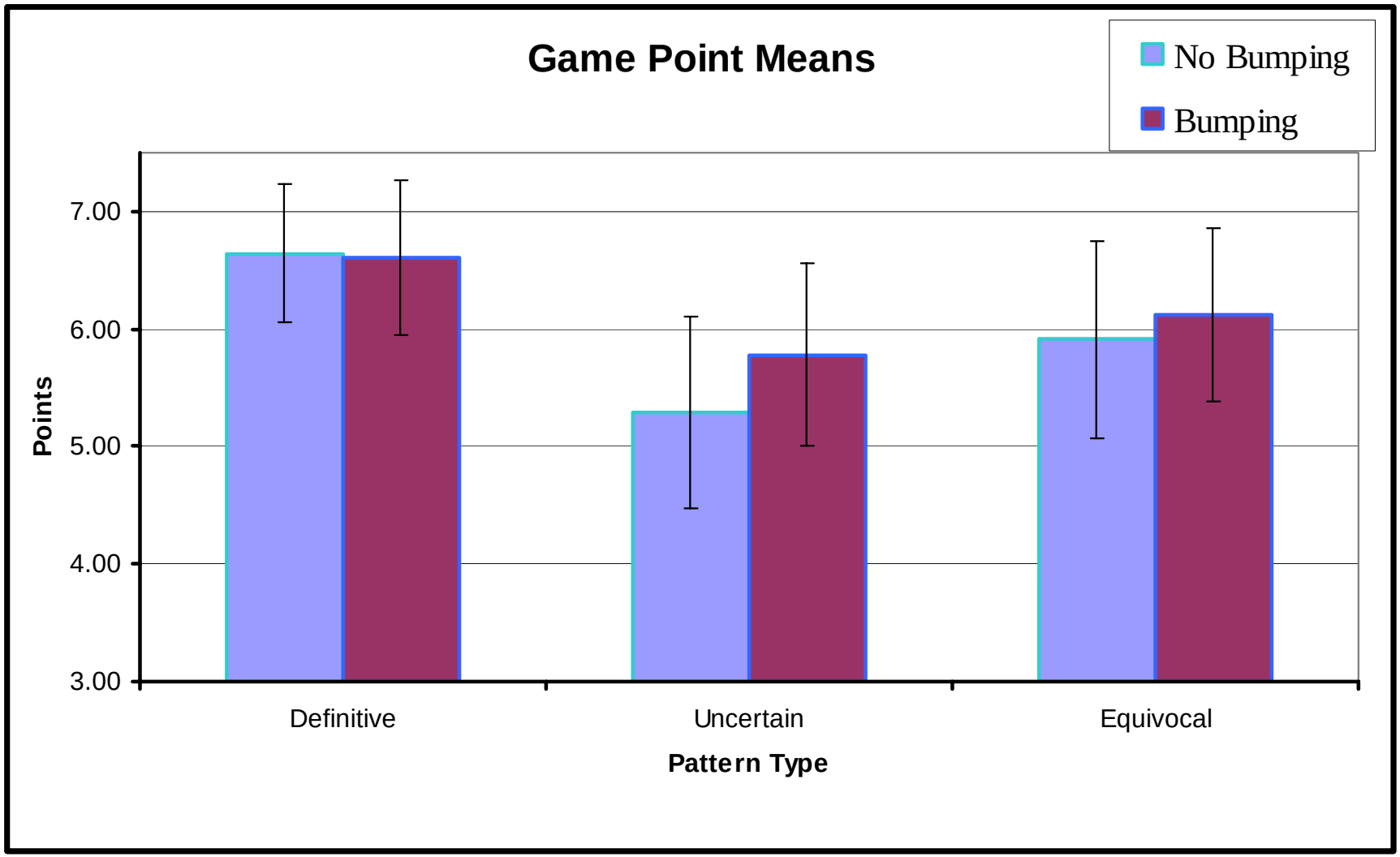
Correlation between Sharing Correctness and Good Moves = 0.25 ($p < 0.05$)

Move Time (Seconds)

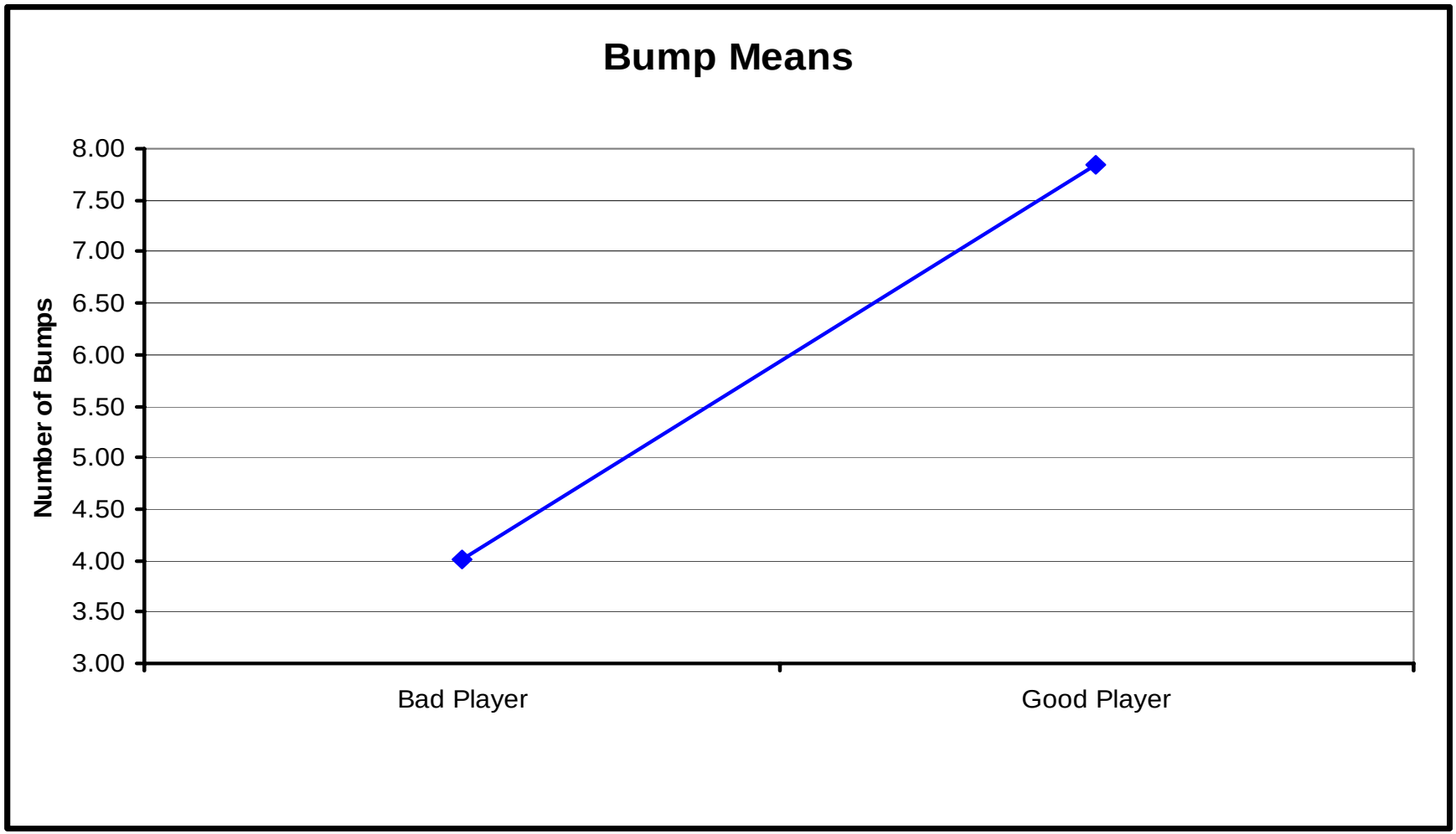


Time pressure when moving…

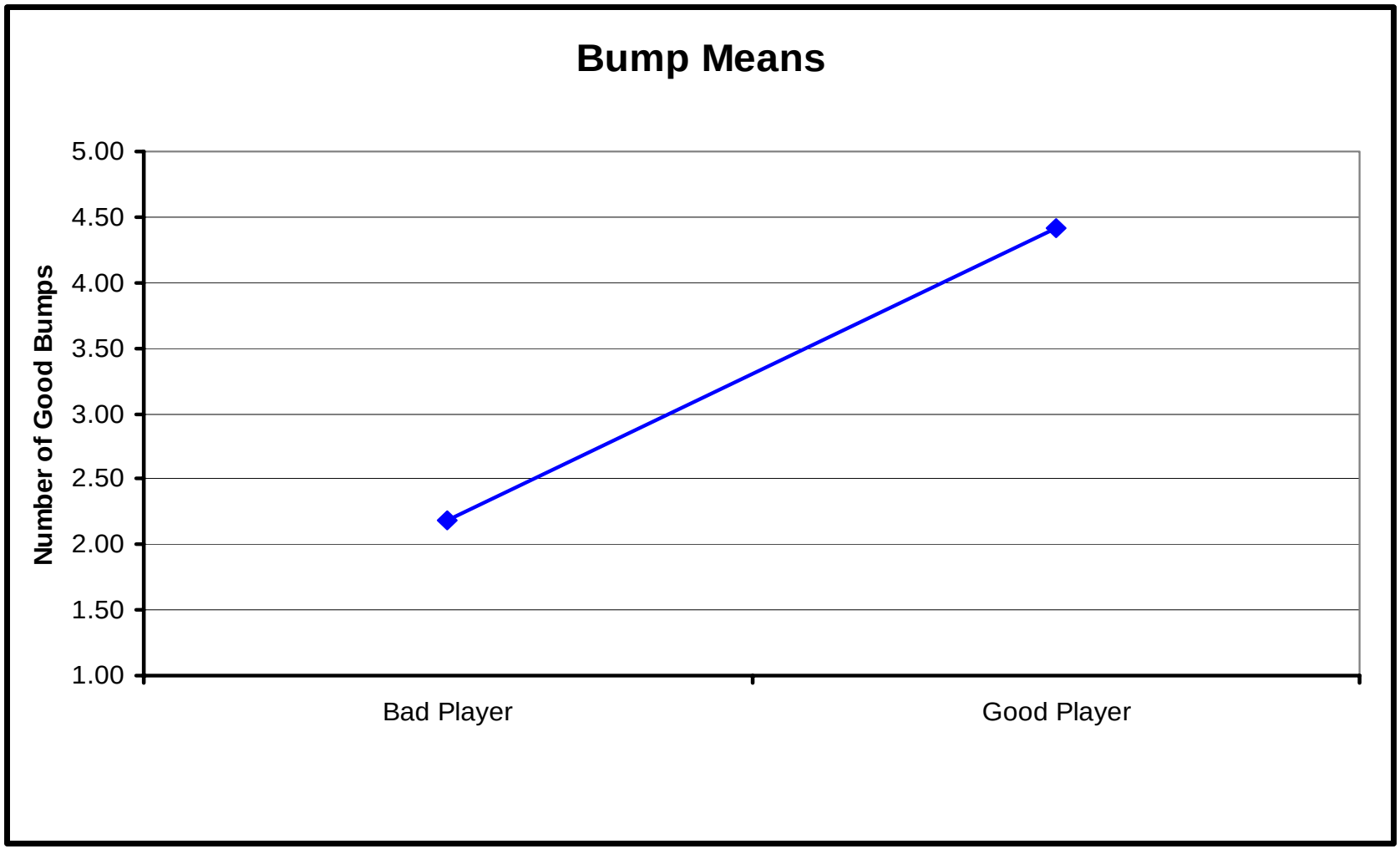
Bumping and Performance



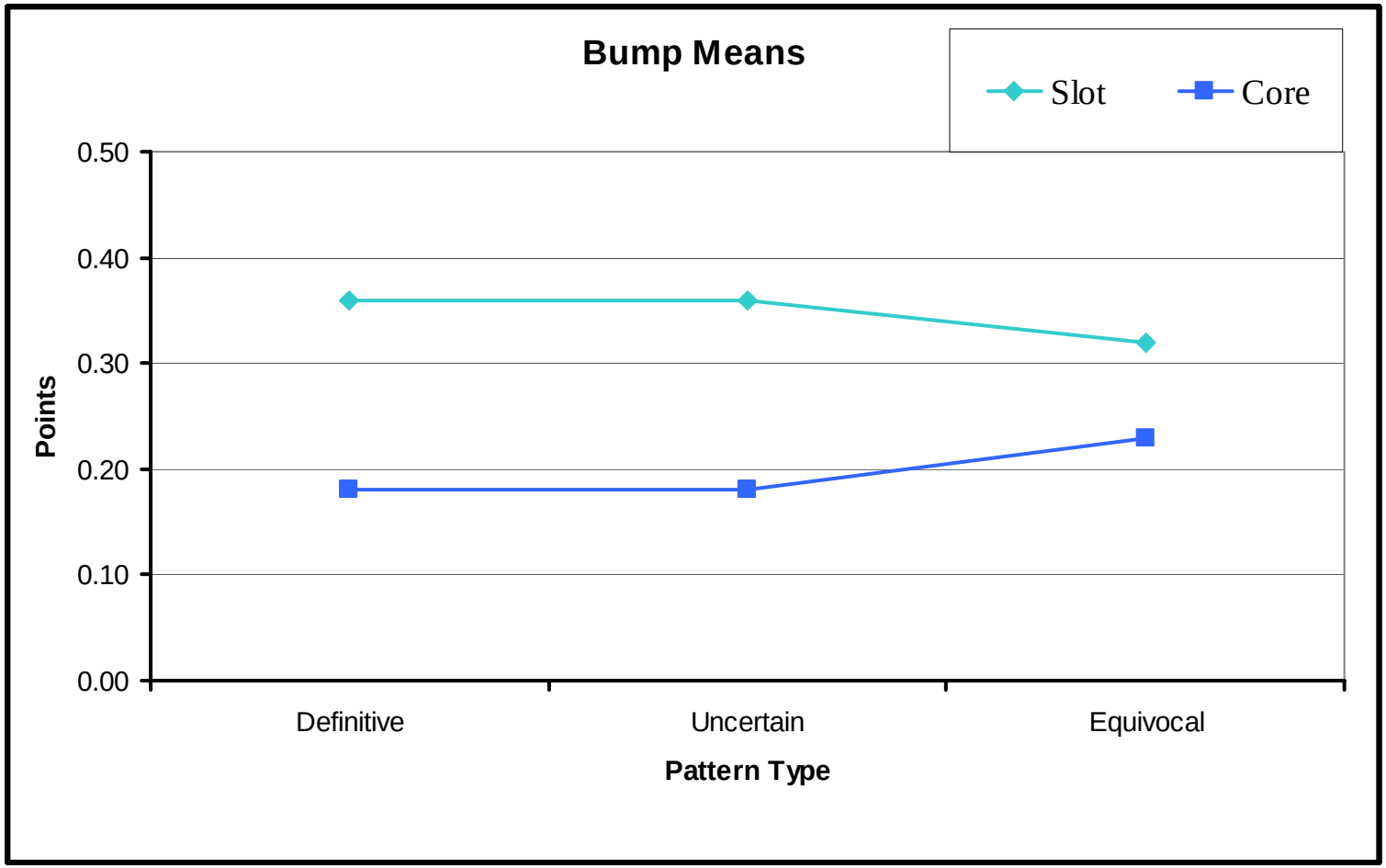
Player Type and Number of Bumps



Player Type and Number of Good Bumps



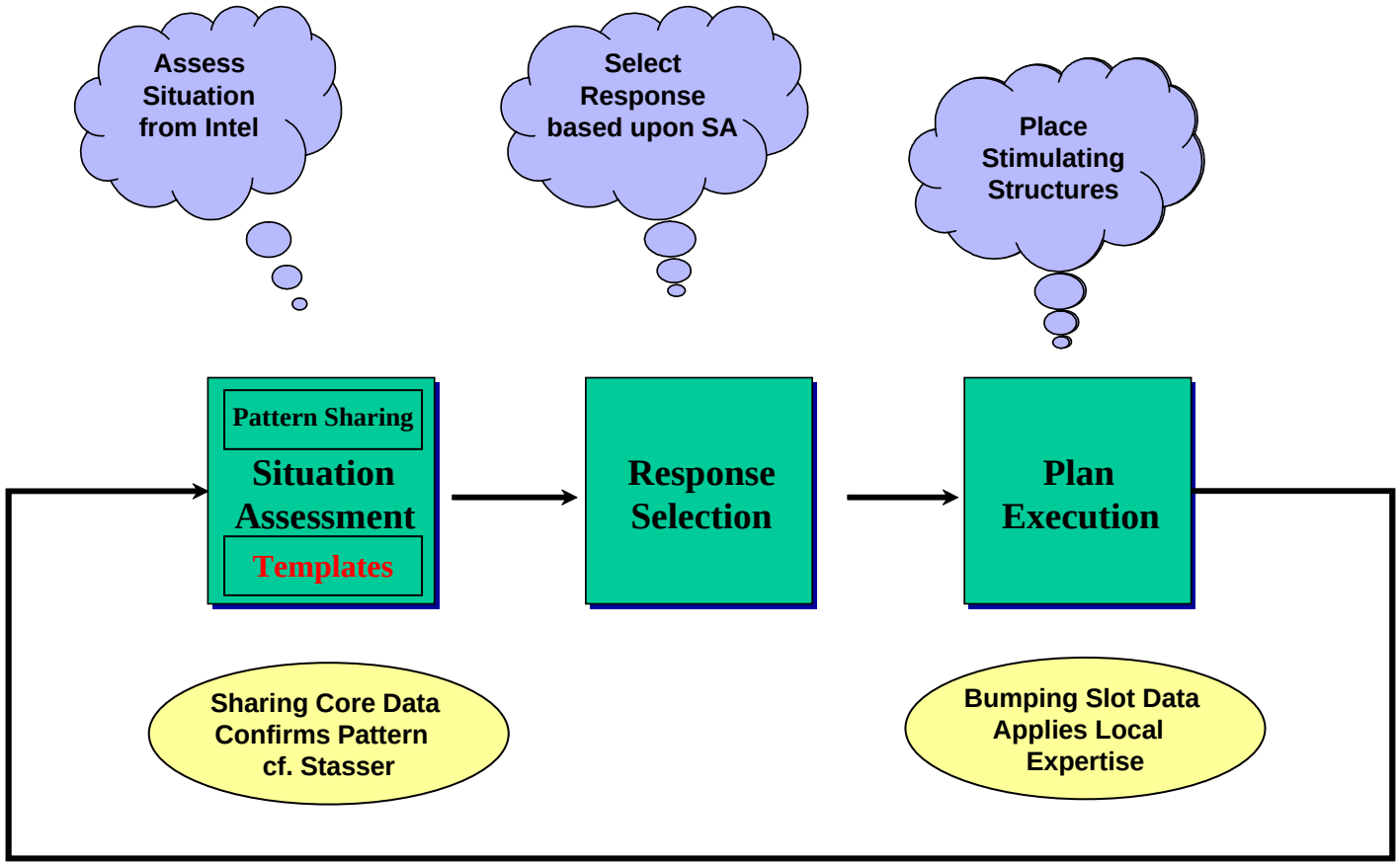
Core vs. Slot



Conclusions

- Team Recognition Primed Decision Making Model Continues to be Validated
- Sharing of Pattern **Chunks** Improves Performance
  - Cognitive Alignment
  - Ultra Thin tool
- Support for Gobet/Simon Template Model…
  - knowledge exchange (bump) on *slot* data!!!

Research Model



Team Recognition Primed Decision Making

Transitions to Navy Tasks

- Principles
  - Provide Pattern-Sharing Tool for SA Task
  - Provide Stimulating Structure Tool for Action Task
  - Transform Effortful Cognitive Tasks into Simple Perceptual Tasks

FY 2004 Plans and Onward

- Change task domain (increase complexity)
- Operational Task (continuous performance)
  - Continue to core/slot concept
  - Manipulate the ability of team members to “push” or “pull” pattern information from their teammates (negotiated interrupts)
  - Manipulate team roles (peer, hierarchical, etc.)

NEO – when the plan breaks…

- Personnel Selection completed
- Training completed
- Planning completed
- Operation underway
  - Contingency theory about sharing core/slot data
  - Prescriptions for user interfaces
  - Empirical testing with the “hairy water buffalo”

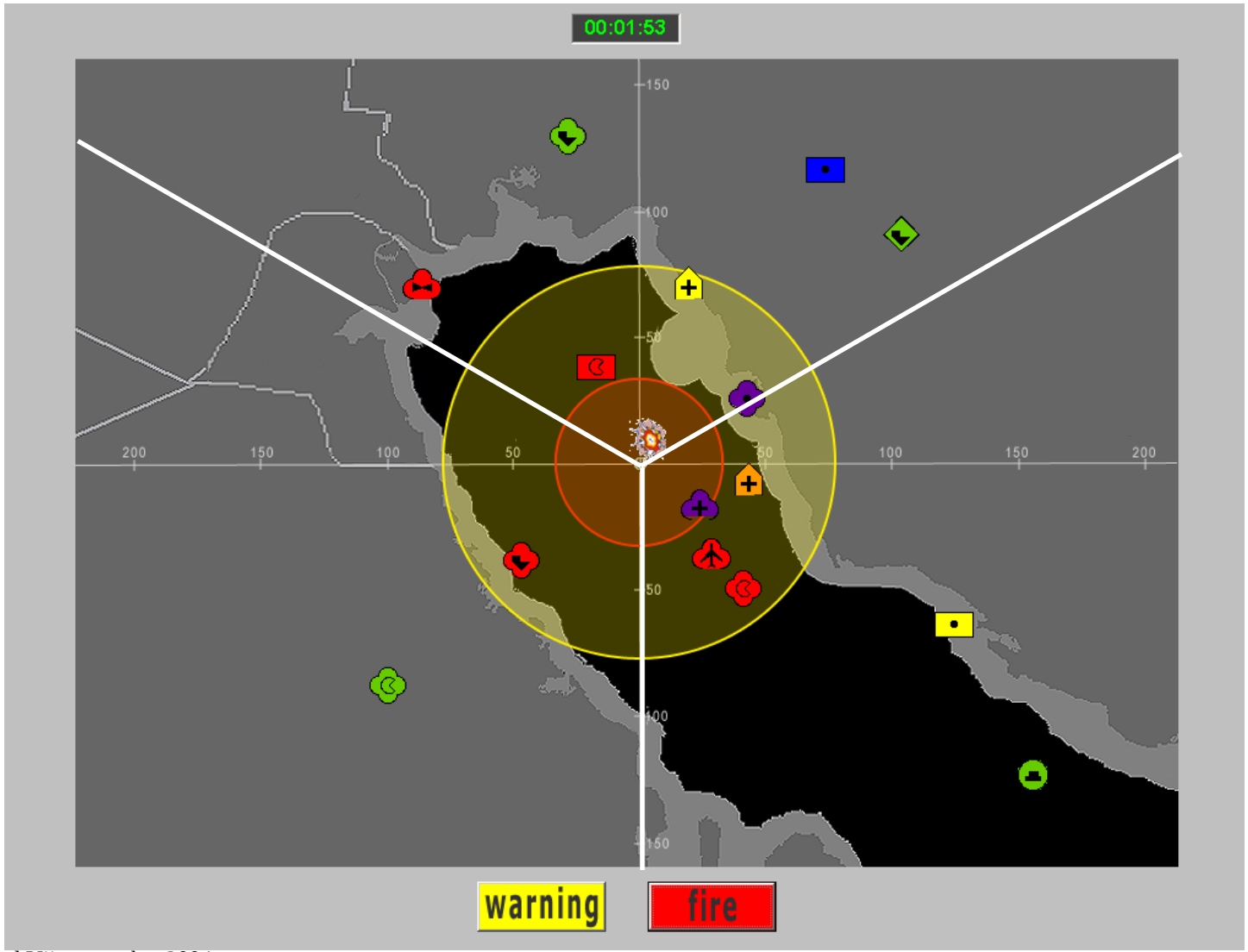
Operational Task Research Design

- Team Warship Commander Task
  - 3 person teams
  - Zones of influence
- Comparison:
  - Message-based tool vs. Perceptual Push Tool
- Common briefing for Core Data items
  - E.g., red symbols are hostile, blue are friendly
- Private briefing for Slot Data items
  - E.g., anything with a dot in the middle is hostile

Research Design (cont.)

- Within Subjects, treatment counterbalanced
- Rewards for performance
- Independent Variables
  - Count of Type 1 and Type 2 errors
  - Count of Core Data shared
  - Count of Slot Data shared

Team Warship Commander



Team Warship Commander

Screen Video

Team Member Video

Operational Task Research Hypotheses

- H1: A Pattern-Sharing Tool is useful in Situation Assessment Phase to achieve consensus about Core Data
- H2: A Stimulating Structure is useful in Action Phase to reveal local expertise about Slot Data
- H3: Stasser's findings re sharing of common vs. private data reflect Core vs. Slot Data during Situation Assessment Phase

Pilot Study Results

- Teams unable to attend to both tasks
- Some teams attempt to share slot data
- Teams unable to hold knowledge in short term memory
  - Large numbers of “type 2” errors

Chat Transcripts…

00:00:12 1- yellow w hat inside bad
00:00:46 2- honeycomb with plus bad
00:01:27 3- what colors??
00:01:43 1- square w plus bad
00:01:51 3- colors
00:02:01 1- orange square w plus
00:02:41 2- yellow honeycomb with plus bad
00:02:50 2- purple rectangle with dot bad
00:03:00 2- purple triangle bad
00:03:16 3- square or rectangle with plus bad?
00:03:40 1- hat inside yello dome bad
00:04:43 3- diamond with hat inside green bad
00:04:59 3- clover with dot inside green bad
00:05:45 3- clover with hat inside purple bad
00:06:31 3- on purple triangle bad what is inside it and do you mean diamond?
00:07:04 2- purple diamond with anvil inside
00:08:47 1- yellow hat in yello dome bad
00:10:11 3- refresh on orange bad?
00:10:14 3- details again
00:10:19 3- color and shape and whats unside
00:10:27 1- orange dimaond w plus bad
00:00:39 3- purple rounded-clover shape with squarish black center is hostile
00:01:40 2-
00:01:45 3- green 4-point diamond is hostile
00:02:33 3- green rounded-corner cloverleaf with dot is hostile
00:04:49 3- can anyone see what i'm typing???
00:05:06 1- ywa
00:05:07 1- yes
00:05:16 1- too busy
00:06:17 1- watch to see who bnlows up who in yellow
00:07:18 2- purple rectangle w black dot is bad
00:10:29 2- yellow clover w cross is bad
00:10:31 1- diamond yellow with plus = hostile
00:10:48 3- good good info is good
00:11:02 3- it's easier for me to watch my own sector with more info
00:11:07 1- all you need to do is see who blows up who in yellow!!

Questions?